DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF

NEDPL-PS

RECONNAISSANCE REPORT

TEN MILE RIVER

CHESHIRE, CONNECTICUT

AUGUST 1983

1. AUTHORITY

Reconnaissance scope investigation for providing local flood control improvements along the Ten Mile River in Cheshire, Connecticut (see Plate 1) have been completed under authority contained in Section 205 of the 1948 Flood Control Act, as amended, by Section 2 of Public Law 97-140 dated 29 December 1981. This report was prepared in accordance with ER 1105-2-10, dated 5 February 1982. Federal assistance was requested by letter dated 28 April 1983 from Edward T. O'Neill, Jr., Town Manager of Cheshire.

Under the provisions of the Section 205 authority, Federal funding is made available to construct small flood control projects, limited to a Federal cost of not more than $4 million. The project must be complete-within-itself and economically justified.

2. DESCRIPTION OF AREA

The town of Cheshire is located in the northern portion of New Haven County in central Connecticut. It is bordered by the city of Meriden and the town of Southington to the north, the town of Wallingford to the east, the town of Hamden to the south, and the city of Waterbury and the town of Prospect to the west. Cheshire is approximately 25 miles from Hartford, Connecticut, and had a 1980 population of 21,545. The total land area within the town limits is 33 square miles, with a population density of 653 persons per square mile.

The climate of Cheshire is moderate and is characterized by the even distribution of approximately 45 inches of annual precipitation. There are large ranges of temperature, both daily and annually with a considerable variety of weather in short periods of time.

The topography of Cheshire ranges from gently rolling terrain in the river valleys to steep hilly terrain in several upland areas. The town land area consists mainly of soil developed on well-drained, glacial stratified drift in the valleys and glacial till and bedrock in the uplands.

3. WATERSHED DESCRIPTION

The Quinnipiac River, the principal stream in Cheshire, has a drainage area of 76 square miles at the downstream corporate limits. The Ten Mile River is an ungaged tributary to the Quinnipiac River and is located in central Connecticut. It originates in the town of Prospect, Connecticut, just over the Prospect-Cheshire town line and flows in a northerly direction passing through the towns of Prospect, Cheshire and Southington for a total distance of about 7.0 miles. The Ten Mile River has a drainage area of about 20.6 square miles of which about 17 square miles lie upstream of the Southington-Cheshire town line and about 3 square miles within Cheshire. The Ten Mile River has a total fall of about 300 feet in its 7.0 mile course of which about 120 feet are in the 4.8 miles through Cheshire and about 7 feet in the 0.8 mile through Southington.

Discharge Frequency. For purposes of this reconnaissance level investigation, discharge frequency information for the Ten Mile River was developed by statistical analysis of available long-term streamflow data in the region. The Quinnipiac River gage record at Wallingford, Connecticut, with a drainage area of 110 square miles and 52 years of record, was used. Discharge frequencies for the Ten Mile River were considered proportional to those at Wallingford by a ratio of respective drainage areas to the 0.7 exponential power. The adopted frequency curve indicates that the 10-year frequency flow of 1100 cfs meets the criteria for Corps involvement (10-year frequency - 800 cfs).

4. PRINCIPAL FLOOD PROBLEMS

Floods in Cheshire have occurred in every season of the year. Spring floods are common and are caused by a combination of rainfall and snowmelt. Floods in late summer and fall are usually the result of hurricanes or other storms moving northeast along the Atlantic coast. Winter floods result from occasional thaws, particularly in years of heavy snowfall.

Major floods of the past 50 years occurred in Cheshire in March 1936, January and September 1938, January 1949, August and October 1955, and June 1982 with the most severe being the September 1938 and June 1982 floods. Streamflow records at the U.S. Geological Survey (USGS) gaging station on the Quinnipiac River in Wallingford indicate that the September 1938 flood was equivalent to a flood having a recurrence interval of about 100 years.

During recent years, residential as well as commercial-industrial properties located within the downstream areas of Cheshire (Peck Lane and vicinity), have experienced damages caused by frequent flooding from the Ten Mile River. The most significant damages were reported during the June 1982 flood.

A cursory hydraulic assessment of the Ten Mile River for the high damage areas of Cheshire was made with the aid of existing Flood Insurance Studies accomplished for the towns of Cheshire and Southington. It was determined that water levels in the Peck Lane vicinity are controlled in part by a small dam located in Southington, about 100 feet downstream of the Route 66 bridge, a conduit under the Farmington Canal, as well as by the extremely flat gradient river. During high flows significant hydraulic losses occur at the Route 66 bridge and at the opening through the historic Farmington Canal in Cheshire. This canal crosses the Ten Mile River midway between Route 77 and Peck Lane or about 4,500 feet downstream of Peck Lane.

5. FLOOD DAMAGES

A total of 15 establishments have been identified as having significant flood problems. The 15 are comprised of 7 residences, 1 municipal and 7 commercial or industrial establishments. The majority of the structures are within the 25 to 30-year flood plain. One group of structures on Kurtz Farms is susceptible to flooding from a 5-year event. During the June 1982 flood (approximately a 100-year event), damage to the 15 establishments exceeded $500,000.

A damage survey of the study area was undertaken in May 1983. Local officials and property owners were interviewed to obtain current flood damage data. Dollar value estimates were made for physical damages to site, structure, contents and utilities. In addition, estimates of nonphysical losses were made to include emergency costs for shelter and subsistence and the effects of flooding on normal business operations. Damage estimates were made in 1-foot increments from the point of zero damage to 5 feet above the June 1982 flood. All estimates were referenced to the June 1982 event.

Recurring losses are those potential flood damages which are expected to occur at various stages under present day development. Recurring losses for the study area are presented below.

Recurring Losses

Frequency (yrs)	Damage ($)
5	$ 3,000
10	26,000
50	175,000
100	527,000
500	24,526,000

Expected annual losses were estimated using standard damage frequency integration techniques. Annual damage for the 15 establishments investigated is estimated to be $134,000. The bulk of the annual damage is sustained by commercial and industrial properties. The total annual damage to residences is less than $4,000.

6. PLAN FORMULATION

The primary cause of flooding along the river is the presence of two constrictions within the channel. The farthest upstream constriction is a stone masonry conduit which passes the Ten Mile River underneath the raised Farmington Canal. This conduit is undersized and in disrepair, thus causing backwater flooding in upstream reaches. The second channel constriction is the Route 66 bridge over the Ten Mile River.

This reconnaissance scope evaluation of alternative methods for local flood protection along the Ten Mile River focussed on several separate and combined plans. These include:

(1) Upstream reservoir storage

(2) Diversion of flood flows

(3) Floodproofing

(4) Channel Modification

  (a) remove constriction at Farmington Canal

  (b) remove constriction at Route 66 bridge and at the Farmington Canal

(1) Upstream Reservoir Storage - Upstream reservoir sites were identified and preliminary evaluation indicated they would have little effect on the overall Cheshire flooding problems because they were either too far upstream from the problem area or they did not control a significant portion of the watershed.

(2) Diversion of Flood Flows - Diversion of flood flows around the Farmington Canal, which is the first major constriction in the river, was evaluated. The 3,000-foot long channel would have a bottom width of 20 feet and a depth of 10 feet. The channel has the capacity to pass the 100-year flood flows without causing significant damage to the properties in Cheshire. Preliminary cost of this plan is about $1.1 million and has a benefit-to-cost ratio 1.4 to 1.0.

(3) Floodproofing - Floodproofing was considered for the five industrial buildings subject to flooding. The floodproofing would include waterproofing the exterior walls of the structures and installing water tight closures over all openings. These industrial facilities are very large and because of this the estimated cost to floodproof them is in excess of $1.4 million. The benefit-to-cost ratio for this floodproofing plan is just over unity.

(4) Channel Modification - The Route 77 bridge is a small two lane bridge crossing the Ten Mile River. The bridge is made of concrete and steel with masonry stone abutments. The downstream bridge opening is 18.5 feet by 9.0 feet and is the hydraulic control. Downstream (about 100 feet) from the Route 66 bridge is a small rubble dam 3 or 4 feet high. Slope protection is provided on the right bank downstream from the bridge. Some erosion and scour was noticed on the right bank adjacent to the bridge extending 50 feet downstream. Our hydrologic analysis reveals the bridge opening is undersized and requires an additional 175 square feet to pass the 100-year storm.

The abandoned Farmington Canal is on top of an embankment approximately 25 feet high. A stone masonry conduit (undersized) passes underneath the above embankment carrying the Ten Mile River which backs up causing flooding during high flows. No plans are available for the Farmington Canal ebankment. The embankment appears to be an earthfill with approximately a 40-foot crest width, 25 feet in height above the existing conduit with a 1 vertical to 3 horizontal upstream slope and 1 vertical to 2 horizontal downstream slope. The slopes are presently overgrown with trees up to 12 inches in diameter. The canal embankment acts like a dam when the flood flows along the Ten Mile River exceed the conduit capacity.

For purposes of preliminary studies the following stream channel improvements were considered for the Ten Mile River: (a) remove a portion of the Farmington Canal embankment for improved hydraulics and (b) modify Route 66 bridge for improved hydraulics. All improvements were sized for the 100-year frequency discharge of about 2,100 cfs. Modified flood levels, as a result of the improvements were determined by approximate calculations believed adequate for preliminary costing purposes. The cost of the Farmington Canal modification alone is $230,000 and has a 6.8 to 1.0 benefit-to-cost ratio. This modification combined with the Route 66 plan would cost about $470,000 and have a benefit-to-cost ratio of 3.5 to 1.0.

7. RECOMMENDED PLAN

Reconnaissance investigations indicate that channel improvements at the Farmington Canal crossing and the Route 66 bridge represent the most cost effective methods of reducing future flooding problems in Cheshire. Either of the channel improvement plans provides an effective flood control project that is acceptable to local interests.

Specific features of the recommended plans include:

FARMINGTON CANAL MODIFICATION

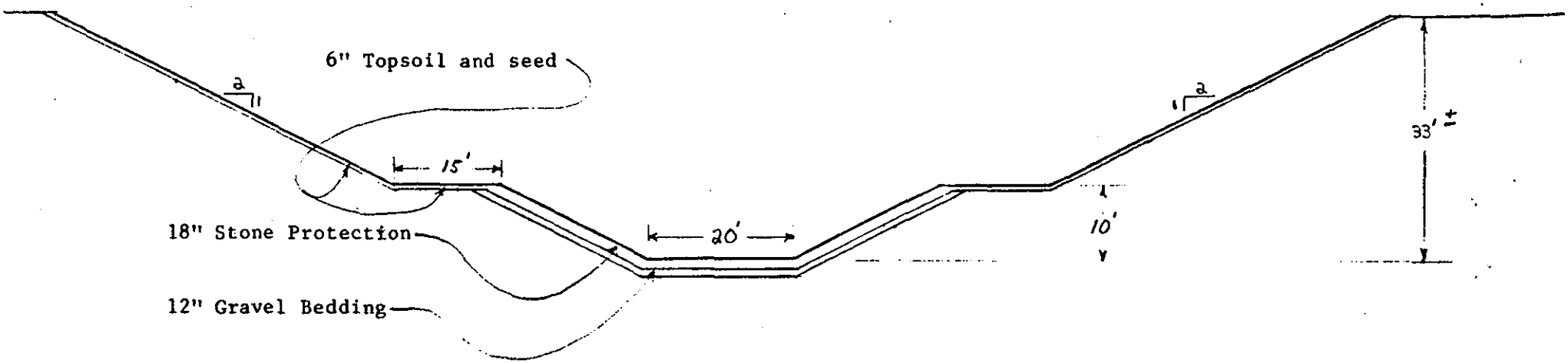
To alleviate flooding upstream of the stone masonry conduit, an open channel with stone slope protection through the Farmington Canal embankment has been evaluated (see Plate 2). The proposed channel would have a bottom width of 20 feet and side slopes rising 10 feet above the channel bottom with a 1 vertical on 2 horizontal slope. The length of the proposed channel is approximately 195 feet with the channel cut ranging up to a maximum of about 33 feet. Two schemes for this new open channel were developed. The first cost estimate was developed centering the new channel at the location of the existing stone conduit and using temporary steel sheet piling for control of water. The construction cost estimate for this scheme is $210,000, which includes $58,000 for the temporary sheet piling.

A second method to control water was also evaluated for construction at this location. Water would be controlled during construction by a temporary culvert. The cost estimate using this method to control water is $168,000, and includes $25,000 for the temporary culvert. Relocating the new open channel adjacent to the existing conduit and other schemes involving installation of new covered culverts were not considered as part of this reconnaissance effort because of obvious higher costs. If it is determined that preservation of the existing canal has a significant historic/archaeological concern, installation of conduits and restoration of the canal can be evaluated during a later study phase.

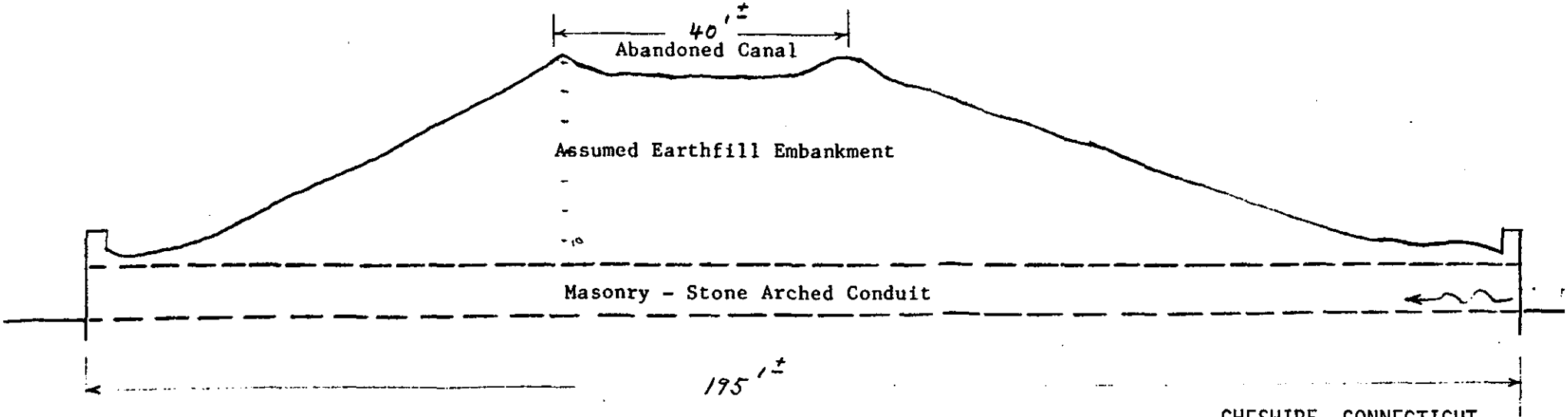
Route 66 Bridge Modification

Two alternatives were viewed as potentially feasible means to reduce the backwater flooding resulting from the existing Route 66 bridge. Our hydrologic analysis revealed that the bridge cross-section requires an additional 175 square feet of opening to pass the 100-year storm. The first alternative is to place a cut and cover reinforced concrete twin box conduit adjacent to the existing bridge. Looking upstream, the new twin box culvert could be placed to the right of the existing bridge. The two openings would each be 12 feet X 7.5 feet, providing an additional 180 square feet to pass flood flows (see Plate 3). The construction cost estimate for the twin concrete box culvert is $180,000.

A cost estimate was developed for replacing the existing bridge with one of sufficient opening to provide the additional 175 square feet of channel required. A bridge span of 55 feet would provide this additional cross-sectional area. The bridge width will remain the same, approximately 40 feet. Based on standardized cost curves for bridge construction, the cost estimate to remove the existing bridge and construct a replacement bridge is $630,000.



PROPOSED SECTION - THROUGH FARMINGTON CANAL



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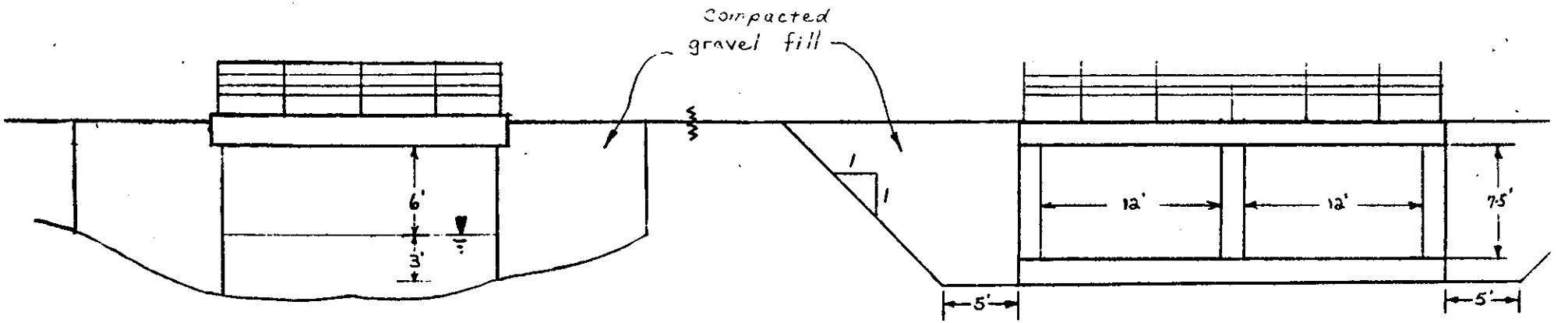
FARMINGTON CANAL PLAN

PLATE 2



EXISTING ROUTE 66 BRIDGE

DOWNSTREAM ELEVATION

PROPOSED SECTION R C TWIN BOXED CONDUIT

LOCATED ADJACENT TO EXISTING BRIDGE

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ROUTE 66 BRIDGE PLAN

PLATE 3

The twin box culvert at this location was found to be more cost effective. Table 1 lists the costs for the two plans of improvement for the Ten Mile River.

8. ECONOMIC JUSTIFICATION

Benefits accruing to the 2 channel improvement alternatives have been tabulated. They are the new open channel through the historic Farmington Canal and the new box culvert at Route 66 in conjunction with the new open channel at the canal. Neither alternative eliminates all the flooding but both alternatives reduce flood stages over the entire range of flood events. Residual losses are those flood damages which would still occur under the "with" plan condition.

Stage frequency curves, modified by channel improvements were used to determine annual residual losses. Annual benefits for channel improvements were determined by subtracting the annual residual losses from the annual losses under existing conditions and are presented below.

Annual Flood Control Benefits

and Residual Losses

Alternative	Annual Benefit	Annual Residual Loss
Improvements at Canal Only	$ 125,000	$ 9,000
Improvements at Canal and at Route 66	$ 132,000	$ 2,000

A summary of estimated first costs, annual costs, annual benefits and benefit-to-cost ratios for the measures described follows:

Economic Analysis

Feature	First Cost	Annual Cost	Annual Benefits	B/C Ratio
Improvements at Canal Only	$230,000	$18,500	$125,000	6.8
Improvements at Canal and at Route 66	$470,000	$38,000	$132,000	3.5

Annual costs for flood control are amortized over a 50-year period at a current interest rate of 7-7/8 percent. First costs include contingencies, Engineering & Design and Supervision & Administration.

TABLE 1

COSTS OF FLOOD CONTROL PLANS

PLAN 1 - Improvements at Canal Only

New Channel	$ 115,000
Temporary Conduit Diversion	20,000
TOTAL COST	$ 135,000
25% Contingency	33,000
TOTAL CONSTRUCTION COST	$ 168,000
Engineering & Design	35,000
Supervision & Administration	27,000
TOTAL PROJECT COST	$ 230,000

Total Annual Cost ($230,000 X 0.08057) = $18,500

PLAN 2 - Improvements at Canal and Route 66 Bridge

New Channel	$ 115,000
Temporary Conduit Diversion	20,000
Twin Box Culvert at Bridge	144,000 *
TOTAL COST	$ 279,000
25% Contingency	69,000
TOTAL CONSTRUCTION COST	$ 348,000
Engineering & Design	70,000
Supervision & Administration	52,000
TOTAL PROJECT COST	$ 470,000

Total Annual Cost ($470,000 X 0.08057) = $38,000

* Non-Federal cost

9. ENVIRONMENTAL ISSUES

The Farmington Canal is presently on the State of Connecticut Register of Historic Places. The following paragraphs were taken from "Connecticut, An Inventory of Historic Engineering and Industrial Sites."

> "The Farmington Canal, Connecticut's largest pre-railroad engineering project, grew from the rivalry between merchants in Hartford and New Haven. At issue was control of trade with the upper Connecticut River valley in Massachusetts, Vermont and New Hampshire. Hartford, on the bank of the river, was advantageously situated for this trade. By the early 1820's canals had been built to bypass all the rapids on the Connecticut River except for Enfield Falls, just north of Hartford. New Haven interests hoped to take advantage of Hartford's position below the falls by building a canal over an inland route between New Haven and a point on the river in Northampton, Massachusetts. In 1922 the 17 Connecticut towns on the route hired Benjamin Wright, engineer for the Erie Canal, to survey the proposed line. On the basis of that survey Connecticut's General Assembly chartered the Farmington Canal Co. to construct and operate the canal. Hartford representatives in the General Assembly, unable to block passage of the charter, were able, however, to prevent State subsidy of the project. Except for some assistance from New Haven, the company had to rely on private subscriptions and occasional bond sales for capitalization. In 1823 the Massachusetts legislature chartered the Hampshire and Hampden Canal Co. to build the Massachusetts section. Construction began in 1825.
>
> The canal ran approximately 80 miles, with 58 miles in Connecticut. Over most of its length it was 4 feet deep, 20 feet wide at bottom and 36 feet wide at top. Towpath and embankments totalled some 30 feet in additional width. For most of the route the walls were simply banks of locally available soils with no shoring or capping. The 213-foot rise between New Haven and the Massachusetts line was taken in 28 locks. There were 3 aqueducts and some 15 culverts crossing rivers and creeks. The Connecticut section opened in 1829, the Massachusetts section in 1835; the two were merged into the New Haven and Northampton Canal Co. in 1836.
>
> Portions of the canal survive today in various states of repair. The masonry in many culverts and other structures has been taken and reused; the banks themselves became

sand quarries in many of the towns. Lengths of several thousand feet or less are found in Suffield, Simsbury, Avon, Farmington, Plainville, Cheshire and Hamden. In Plainville's Norton Park the town has restored 700 feet of canal and towpath. Where the canal crossed Ten Mile River in northern Cheshire an 18-foot wide masonry-arch culvert survives in good condition. Lock 12 in Cheshire is the best-preserved structure; about 12 feet wide and 100 feet long, it has mortared walls of random-coursed sandstone blocks. The present mortar and timber gates were added during recent reconstruction. Immediately south of the lock stands a masonry-arch bridge that carried the railroad over the canal."

Preliminary discussions with the State indicate no problem with our planned open channel through the Farmington Canal.

10. REQUIREMENTS OF LOCAL COOPERATION

Local officials are aware of the requirements for local cooperation and participation in a local flood protection project along the Ten Mile River in Cheshire, Connecticut. The town will provide the following assurances:

(1) Provide without cost to the United States all lands, easements, rights-of-way, utility relocations and alterations, and highway bridge construction and alterations necessary for project construction.

(2) Hold and save the United States free from damages due to the construction, operation, and maintenance of the project except where such damages are due to the fault of the United States or its contractors.

(3) Maintain and operate the project after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army. Annual operation and maintenance costs are currently estimated to be $1,000.

(4) Assume full responsibility for all project costs in excess of the Federal cost limitation of $4 million. The Federal cost limitation includes costs of all investigations, planning, engineering, supervision, inspection, and administration involved in development and construction. Federal costs are currently estimated at $230,000.

(5) Prevent future encroachment which might interfere with proper functioning of the project for flood control.

(6) Provide a cash contribution for project costs assigned to project features other than flood control.

(7) Comply with the requirements of non-Federal cooperation specified in Sections 210 and 305 of Public Law 91-646 approved 2 January 1971 entitled the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

11. CONCLUSIONS

Based on the reconnaissance investigations completed to date, it has been determined that the most economical solution to the flooding problems in Cheshire is channel modification. The two channel modification solutions recommended by this report include removal of a portion of the Farmington Canal embankment yielding a 6.8 to 1.0 benefit-to-cost ratio and modifying the Route 66 bridge in conjunction with removing a portion of the canal yielding a benefit-to-cost ratio of 3.5 to 1.0.

If one of the historical agencies either on the local, State or National level decide the Farmington Canal should be preserved, it would be necessary to recommend the diversion plan or the floodproofing plan.

12. RECOMMENDATIONS

I recommend that this report be approved and that $150,000 be allocated to the Cheshire, Section 205 account to complete the necessary detailed project studies.

CARL B. SCIPLE
Colonel, Corps of Engineers
Division Engineer